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From Data to Discourse

How Communicating Civic Data Can Provide a Participatory Structure for Sustainable Cities and Communities

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Abstract

This study explores how Civil Society Organizations (CSOs) have leveraged civic data to facilitate democratic participatory structure for sustainability transitions around the case of bicycle counters in three US cities over a ten-year period (Seattle, San Francisco, Portland). We identified that CSOs have played crucial roles in public discourse by (1) sustaining long-term public issues through shaping affective as well as analytical discourses and (2) fostering citizens' sense of ownership and contributions toward sensor devices and the data they generate by contextualizing them through local civic life as well as connecting issues to actors in other cities.

Keywords: Civil Society Organizations, Civic Data, Bicycle counter, Participatory structures, Sustainable Development Goals

1. Introduction

Civil Society Organizations (CSOs) is an umbrella term that encompasses different types of networks and institutions ranging from transnational non-governmental organizations to small community groups (United Nations, 2018, para 20). CSOs enable democratic participation and are regarded as central for achieving the UN's Sustainable Development Goals (SDGs). Despite their recognized importance, conventional forms of CSOs have struggled to recruit supporters especially from younger generations (Wells, 2015). New types of CSOs address citizens through performative and quotidian media practices (Foellmer et al., 2018; Mattoni, 2016) creating forms of political activism as "connective action" (Bennett and Segerberg, 2012). The present study analyzes the roles that these new types of CSOs have in sustainability transition, looking specifically into bicycle counters as sensor devices that are visible in public spaces and that become "communicative objects" (Raetzsch and Brynskov, 2018) in public online discourses.

This exploratory case study makes a contribution to understanding new democratic participatory structures in cities and communities (SDG 11.3.2) in the context of CSOs, citizen-centered innovation, and public contestation through social media. We analyze how electronic bicycle counters are becoming accepted and owned by communities in the transition to sustainable cities where the modal share of cycling is required to increase to reduce carbon emissions from car traffic. Such sensor devices generate "civic data" (Hamm et al., 2021) by monitoring citizens' movement but also by generating crowd-sourced, collective representations of change in the city itself that citizens can contribute to. To make civic data actionable, however, data alone is insufficient (Assad et al., 2017; Chen and Aitamurto, 2019; Foth and Brynskov, 2016; Raetzsch et al., 2019; Foth et al. 2011). We want to understand how civic data in the case of bicycle counters are made actionable in public discourses and which roles CSOs play in this process.

Bicycle sensors are visible interventions in urban space, their data represents and monitors diffuse patterns of collective mobility. Through social media, citizens are likewise referencing, challenging, or embedding their own experiences into new forms of understanding change in the city. These overlapping processes of technological intervention and cultural contestation exhibit a slow and rather inconspicuous process of infrastructuring, where different actors circulate different kinds of "communicative objects" (Raetzsch and Brynskov, 2018), highlighting the processes of negotiating and contesting individual and collective meanings of technical infrastructures. By drawing on longitudinal as well as case-based data collections, discourse, and network analysis of social media data, we retrace how the communicative object of the bicycle counter triggers community-oriented perceptions of sustainability transitions around the subject of cycling in the city.

The research question of this study is:

RQ: How have CSOs leveraged communicative objects to facilitate democratic participatory structures in cities around bicycle counters in public spaces?

The study will explore how data generated by the interaction of citizens and bicycle counters becomes a communicative object across stakeholder groups, highlighting the importance of CSOs to shape, moderate and influence such public discourses. In this exploratory mixed-method study, we analyze English-language discourses on Twitter and Facebook around bicycle counters in three US-American cities, focusing on three CSOs in particular. The study makes two core contributions to understand the roles of CSOs to shape participatory structures and make civic data actionable for sustainable cities and communities:

1. CSOs play a significant role in sustaining long-term public issues such as the safety of cycling in the city through affective as well as analytic discourses based on data collected by bicycle counters.
2. CSOs contribute to citizens' sense of ownership of sustainability transitions through enabling and eliciting the circulation of communicative objects, fostering a collective process where the impact of civic data is contextualized in local civic life.

This paper is organized as follows: We first review literature on CSOs' changing use of digital media and the role of civic data in Section 2. We then introduce our data collection, case selection, and methodology in Section 3. In Section 4, we summarize our findings. Then, we discuss the case studies and point out the CSOs' roles in sustainability transitions in Section 5. In the conclusion, we call for a central acknowledgment of CSOs as anchors of civic engagement in networked publics, arguing for the need for democratic participatory structures in the use of civic data for fostering sustainability transitions.

2. Literature Review

2.1 Civil Society Organizations, Connective Action, and Digital Media

Recent social movements such as the Occupy protests in the United States, have created much attention toward the roles of social media as a participatory structure and mobilizing people. As Wells (2015) pointed out, civic participation in the context of digitally-enabled social movements, contributes to the decline of activity in institutional CSOs. Communication is essential but often theoretically underdeveloped to account for the disaffection from politics especially among younger citizens and its link to concrete actions (Kim et al., 2010). Bennett and Segerberg (2012) emphasized that communication itself becomes the organizational structure of the movement. Compared to traditional CSOs these emerging new forms of "connective action" loosely offer variegated ways of public engagement through individual sharing of political ideas, memes, and information on digital media (Bennett and Segerberg, 2012). Similarly, Diani (2015) argued that networks are not just precursors or building blocks of collective action: they are in

themselves organizational structures that engage individuals beyond formalized demands for membership in organizations.

In these new activist contexts, social media play a central role in enabling variegated types of sporadic as well as long-term participation, creating opportunities for mobilization in key instances of a movement as well as forging a joint community spirit from individuals interventions and experiences, a new form of “cloud protesting” (Milan 2015). These developments shift the role of CSOs from being a single institutional and representative actor in political discourses to a networked logic that creates the “glue that binds public and private activity together” (World Economic Forum, 2013, p.5). CSOs and associations of individuals act as a “facilitator in loosely linked public engagement networks” (Bennett and Segerberg, 2012, p.758) of democratic participation (United Nations, 2018; Karpf 2015). The creative use of social media and digital communication formats by CSOs is well recognized as crucial for developing inclusive discourses and narratives around sustainability transitions across different stakeholder groups through experimentation and interventionist practices rather than formalized processes of political participation (Hamm et al., 2021; Köhler et al. 2019; Sengers et al. 2019; Brynskov et al. 2018; von Wirth et al. 2018; Werbeloff et al. 2016).

Many CSOs struggle to transform their traditional participatory structure based on formal membership. New kinds of CSOs have successfully adopted digitally enabled communication modes to leverage a wider participatory potential from their supporters and followers (Karpf 2017). Prominent examples of these participatory modes employed by CSOs include publicizing social issues (Bruns and Burgess, 2011), increasing public discourse visibility (Andrews and Caren, 2010), linking diverse actors (Wonneberger et al., 2020), and mobilizing public attention (Wang et al., 2016). Karpf (2017) emphasizes the need for CSOs to listen to these articulations, arguing that “analytic activism” leverages affordances of digital technologies to fashion new strategic interventions in the political arena. Protest movements filter and moderate both internal and external communication processes where “mediation opportunity structures” are exploited to give voice and visibility to issues of public concern (Cammaerts 2012). CSOs and dispersed social movements are then challenged to both observe, facilitate, articulate, and channel diverse communication streams through new kinds of distributed media and protest practices that link to personalized habits and communication routines of their supporters and followers (Mattoni 2020).

In the broader discourse on sustainability transitions, we conceptualize social media communication as a democratic participatory structure for emerging topics in which CSOs play a central role. While being aware of the various shortcomings of social media technologies, e.g. digital divide, platform logics, algorithmic content amplification, these platforms also offer affordances for CSOs to build up and sustain networks of engaged citizens.

2.2 Civic data

Civic data is commonly understood as data that is both captured and owned by the citizens as a form of the crowd-sourced, open data asset. Its aim is to provide citizens with the means and knowledge to act upon pressing local issues through evidence-based data collections, e.g., on air pollution or radiation (Hamm et al., 2021). The public distribution of civic data needs to be complemented with broader communication strategies that include citizens' shared opinions, emotions, and experiences relating to pressing social issues (Brynskov et al., 2018; Hamm et al., 2021). Collaborative knowledge creation and social change here coalesce with wider public discourses through deliberation in multiple communicative spaces, e.g. in local urban spaces, in the news media, and on social media. Civic data is connected to what Wells (2015) calls "civic information" that is conceptualized as "the continuous flow of facts, opinions, and ideas that help citizens understand matters of potentially public concern and identify opportunities for action" (p.7). While civic data refers to data assets created by and for activists and citizens, civic information refers to the processes of making sense of data and leveraging the impact of big data for social change (Cuquet and Fensel, 2018; cf. Zins 2007).

To make civic data actionable for various actors, however, there is a need to design and implement interfaces that make data accessible to the broader public (Assad et al., 2017; Raetzsch et al., 2019), a structure to appropriate their city to take action for change (Chen and Aitamurto, 2019; Foth and Brynskov, 2016; Hamm et al., 2021) and to be able to institutionalize and grow communities of socio-technical practice in symbiosis with other systems and institutions (Foth and Brynskov, 2016; Gordon and Mihailidis, 2016). In detail, Foth and Brynskov (2016) underscored the importance of civic engagement in a way that allows a multiplicity of voices to be listened to, instead of merely using the pool of data for specific purposes. Finding information that matters requires contextualization based on the specific individual needs of actors. Successful deployments of civic data have been backed up by the process of co-developing a novel technology to solve a target problem by mediating an entire network of social practices and galvanize multiple organizations and user groups (Liu et al., 2019). In addition, social media has become an important structure to generate and disseminate citizen information in local communities and CSOs have assumed important roles as communicators and information producers (Thorson et al., 2020). Meanwhile, generating large amounts of civic data (i.e., civic data overload) has created challenges in processing the data, such as which voices are to be heard and considered by authorities (Chen and Aitamurto, 2019). Thus, we are now more in demand for what research on Digital Civics call for: exploring the potentials of digital technologies "to reconfigure power relations between citizens, communities and the state" (Vlachokyriakos et al, 2016, p.1096).

3. Methodology

3.1 Data collection and Case selection

In this study, we analyze bicycle counters as prominent subjects in English-language online discourse, principally on Twitter and Facebook. The corpus of social media data was constructed through the following two stages. First, we compiled a data set from Twitter and Facebook Pages (excluding Retweets) containing the words “bicycle/cycling/bike counter(s)” for the past 10 years. Twitter data were gathered through the Twitter API with an academic account while Facebook Pages’ posts were gathered through CrowdTangle API with an academic account. We found the oldest available posts in CrowdTangle was in February 2011. Thus Facebook Pages’ data in our corpus covers the data from February 2011 to December 2020 (119 months) while Twitter data covers the tweets from January 2011 to December 2020 (120 months). Due to search queries posted in English, the resulting data set showed a strong majority of activity in US-American cities, the three most prominent ones being Seattle, San Francisco, and Portland. These three cities were identified based on the number of posts that contain location information. We decided to focus on these cities to illustrate the dynamics between civic data, citizens, and CSOs while fully acknowledging that a future study could contain a more targeted search for cities in which bicycle counters were prominently discussed (e.g. Aarhus/Denmark, Amsterdam/Netherlands, Berlin/Germany).

Secondly, we found the most commonly used hashtags related to bicycles in local contexts in the corpus, collected additional Twitter and Facebook data for the past 10 years with those location-based hashtags, and added them to the corpus. The hashtags for the additional data collection are #SEAbike(s), used in Seattle, #SFbike(s) and #bikeSF, used in San Francisco, and #pdxbike(s) (pdx is a nickname of Portland), used in Portland (all hashtags were case insensitive). In total, our corpus consists of 34,037 Tweets and 448 Facebook posts. In addition, for quantitative network analysis (described later in Subsection 3.2), we further collected retweets and replies to the Tweets in our corpus through Twitter API (we did not conduct this further data collection on Facebook Pages’ data because CrowdTangle API does not allow us to do so). These additional data of retweets and replies (53,540 Tweets) are only used for network analysis, not in qualitative in-depth analysis. In addition, for qualitative in-depth analysis, we additionally collected online materials, including reports, media news articles, and press releases, through keyword news article searches and tracking social media data references.

With this corpus, we extracted the accounts of CSOs that have been the most actively communicating in Seattle, San Francisco, and Portland. As a result, we selected the following three CSO cases in three US cities:

- **Case Seattle:** Cascade Bicycle Club (WA) is a statewide bicycling nonprofit organization located in Seattle. Founded in 1970, it has continuously advocated for the safety of cyclists. In Seattle, the first bicycle counter was installed in 2012.
- **Case San Francisco:** SF Bike Coalition (CA) is also one of the oldest bicycle advocacy groups founded in 1971, which has promoted bicycling for everyday transportation (SF Bicycle Coalition, n.d.). San Francisco first installed a bicycle counter in the city in 2013 (San Francisco Municipal Transportation Agency, 2013).
- **Case Portland:** BikePortland.org (OR): BikePortland.org was founded in 2015 as a civic media organization. Portland installed the first-in-the-U.S. bicycle counter in 2012 (Portland Bureau of Transportation, 2013).

Cascade Bicycle Club (Seattle) and SF Bike Coalition (San Francisco) have long histories of cycling advocacy while BikePortland.org is a relatively new organization founded after the rise of social media. We analyze the corpus of social media posts as a whole to capture overall trends of discourses about bicycle counters. We then explore bicycle counters in the case studies of Seattle, San Francisco, and Portland as communicative objects of social media discourse.

3.2 Data Analysis

In this study, we apply mixed methods to explore longitudinal data (2011-2020) on the bicycle counter discourse in Twitter and Facebook. From this large corpus, we focus especially on three cases, which we analyze by social network analysis and critical discourse analysis of linked content outside social media.

For conducting the social network analysis, we construct retweet and/or reply networks of users in the Twitter data enriched by an additional data collection described in Section 3.1. Our network analysis was done with the Python package NetworkX. We created a network graph where each node represents a Twitter account colored according to city-related hashtags, i.e. Seattle related hashtag (#SEAbike(s)) in green, Portland related hashtag (#PDXbike(s)) in orange, and San Francisco related hashtag (#SFbike(s) and #bikeSF) in light blue. Each edge represents a retweet and/or reply connection between accounts. We apply this network analysis to accounts in all three of the selected cases.

For qualitatively examining the corpus, we applied critical discourse analysis (CDA) that has been traditionally used to uncover discourses that maintain power relations of existing elites and institutions (Willig, 2014) and is more recently used to study social media (Bouvier and Machin, 2018) and public discourses around new technologies (Hamm and Lin, 2018). We here apply CDA to understand how civic

data is used to initiate discourses that negotiate sustainability transitions by CSOs, potentially shifting power hierarchies between policymakers, citizens, CSOs, and other stakeholders.

4. Findings

4.1 Patterns of public discourse: From contested innovation to accepted infrastructure

Our corpus consists of 34,358 posts (34,037 Tweets and 448 Facebook Page posts) in the past ten years. Among them, the majority of posts were created by users located in the United States while many posts, in particular Tweets, were by users who do not share location information. In Figure 1, the monthly number of posts in our corpus is plotted over the period from January 2011 to December 2020. Yellow bars represent the posts mentioning the keyword “bicycle/bike/cycling counter(s)” and grey bars show the number of posts with hashtags (#pdxbike(s), #sfbike(s), #bikesf, and #seabike(s), if a post has both bicycle counter keyword and hashtag, the post is counted in yellow bars) in our corpus. Networking through the use of hashtags has been more active on Twitter than on Facebook, a defining feature of user practices on the platform. Over the past ten years, the highest numbers of posts per month typically occur when bicycle counters were set up in cities. For example, the number of posts was highest in August 2012 when the city of Portland installed its bicycle counter (584 posts on Twitter and 24 posts on Facebook). In Facebook Pages, the second-highest number of posts was observed in December 2016 when the city of Santa Monica, California, installed its first bicycle counter (17 posts). Similarly, the highest number of comments, replies, and shares (retweets) occurred at times when the first bicycle counter installations happened: In Facebook, the highest number of interactions occurred when the city of Victoria in Canada installed its first bicycle counters in August 2019, followed by Carmel, Indiana in May 2015. On Twitter, the highest activity occurred when Santa Monica (Dec 2016) and San Francisco (May 2016) installed bicycle counters.

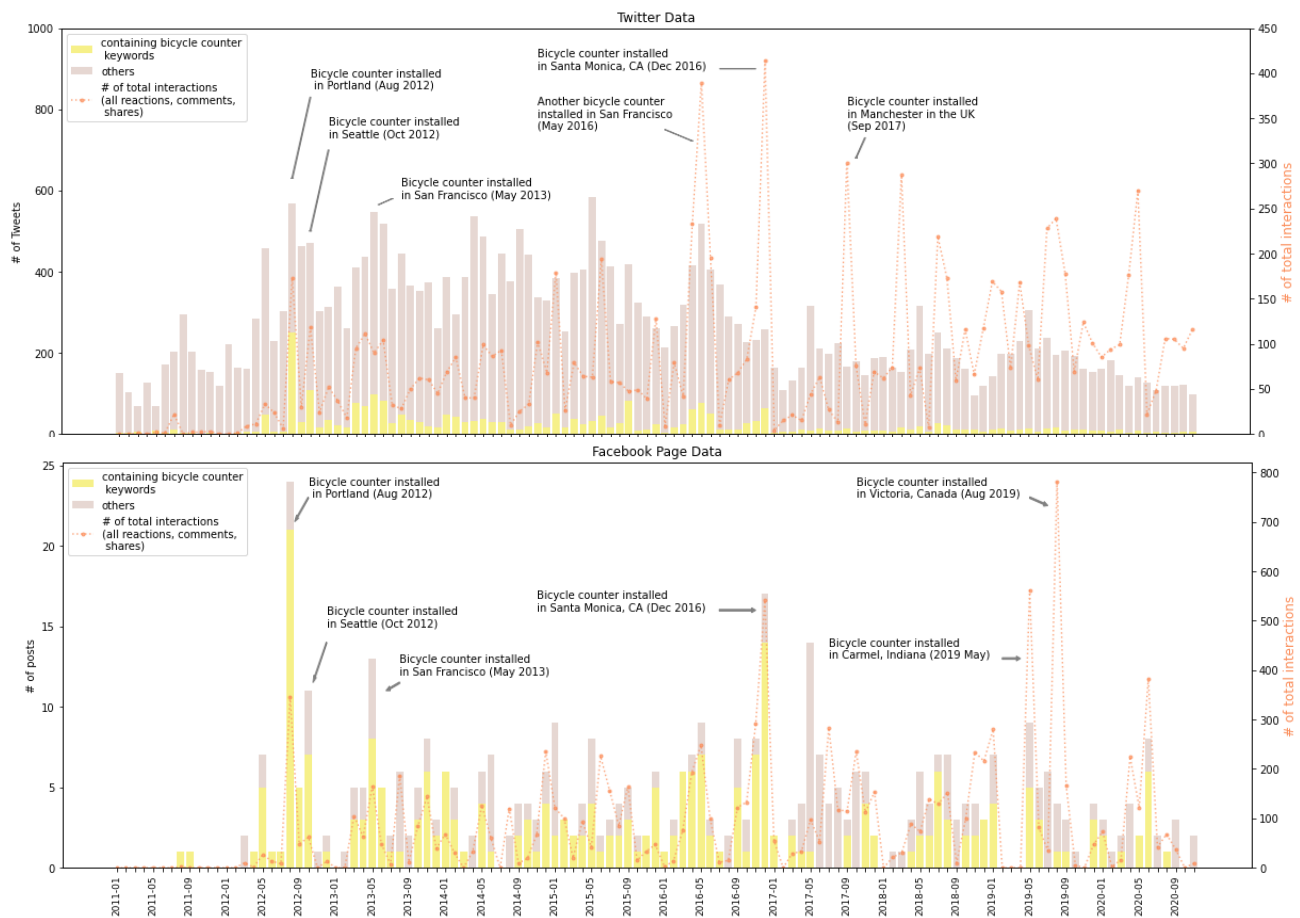


Figure 1. Monthly number of Tweets (top) and Facebook Pages' posts (bottom). The yellow bars represent monthly numbers of posts containing the keywords “bicycle/bike/cycling counter(s)” and grey bars represent monthly numbers of posts containing hashtags (#pdxbike(s), #sfbike(s), #bikesf, and #seabike(s). Orange broken lines depict summed numbers of reactions (replies, comments, and shares) that posts in the month gained. Bars contain only original posts (i.e., no replies, comments, shares, retweets, etc.), the orange line quantifies all reactions to the original posts.). Both in Facebook and Twitter, one of the biggest peaks of communication occurred in August 2018 when the first-US bicycle counter was installed in Portland (584 posts on Twitter and 24 posts on Facebook). Similarly, the number of interactions that posts had, i.e., numbers of comments, replies, and shares (retweet), was the most intense when bicycle counters were installed both in Twitter and Facebook posts.

There were steady numbers of posts in each month since 2011 on Twitter. Since around 2016 yet the total number of posts on Twitter has slowly declined. In particular, the number of posts that include the keywords “bicycle/bike/cycling counter(s)” have decreased since around 2012 and there were only a few posts

containing the keywords after 2017. This might reflect the process of bicycle counters becoming accepted as quotidian elements of urban infrastructures. In addition, new sources of bicycle movement data (e.g. through tracking apps) have complemented stationary counting systems over the last years. In Portland, for instance, the city started to incorporate other types of data that capture bicycle usages and travel patterns, such as purchasing the data from a mobile app company (Maus 2014; Portland Bureau of Transportation, 2018).

Overall, the general pattern of discourse on bicycle counters shows three distinct phases and subjects: installation of bicycle counters as a public event, the process of crowd-sourced data collection, and sharing collective civic data in support of mobility transitions.

4.1.1 Discourses on installing bicycle counters

Throughout the 10-year period of bicycle counter discourse, the installation phase of bicycle counters in the respective cities generated the majority of articulations on social media. The installations of new bicycle counters are typically met with both favorable and unfavorable reactions. Positive reactions are based on excitement about the new means to acquire data and the new experiences of being counted, e.g., *“Great to show car drives how many bike journeys are taken!”*, *“could be useful to argue for more bike lanes,”* and *“Excited I make my rides count!”* The majority of negative reactions refer to using tax money on bicycle counters, such as *“70k would be better used repairing potholes and adding raised sidewalks (sic!)”*, *“How about spend money on helping housing and cars than bike lanes?! Not every soul can bike!”* Such posts also stimulate citizens elsewhere to demand bicycle counters for their cities as well. Comments such as *“why hasn’t the city installed a single bike counter?”*, or *“OK, we are jealous of Portland’s bike counter. Where would you put a bike counter in the East Bay?”* or *“Is Portland’s bike counter a solution for the New York City’s bike ridership debate?”* show the pioneering role of the first cities.

4.1.2 Discourses on the crowd-sourced generation of data

Alongside the collection of civic data on the counters themselves, we see several types of discourse emerging where the counters themselves are becoming communicative objects. One of the most observed types is sharing personalized experiences of being counted. Citizens excitedly document their experiences of being registered by counters through posting images and videos. There are also posts sharing how the presence of counters nudged citizens to use bicycles (more). After counters have become normal and accepted as part of the urban infrastructure, celebrating how bicycle counters hit 1 million cyclists recorded in one year also elicited many positive reactions from citizens. Compared to the installation phase, the number of critical posts about bicycle counters decreases as people contribute to generating data. Only a

few posts criticize the accuracy of data counts, the locations of bicycle counters at highly-frequented roads, or public spending on bicycle counters.

4.1.3 Discourses on interpreting a collective civic data asset

The most prominent yet unique type of discourse in our corpus is about analyzing and interpreting bicycle counter data as a collective civic data asset. The generated civic (and open) data allows anyone (who has the skills and knowledge to do so) to analyze and interpret the data to make sense of bicycles in their cities and construct their own ideas, opinions, and plans for actions. Figures or tables of data eschew an analytical perspective on cyclists' mobility. Many posts show how bicycle use has grown over the years, e.g., by comparing annual numbers of bicycle counts, peaks of commuting hours, or seasonal differences. As more data is accumulated, various types of analyzes contribute to changing people's perceptions of the issue as well as making sense of a collective civic data asset. For example, during the COVID-19 crisis, civic data accumulated through bicycle counters in the US show steep increases in cycling (e.g., a tweet with multiple colored figures showing the analytical results: "*How has COVID-19 affected biking in your city? We're taking a look at Urban Cycling Patterns During a Pandemic: Seattle Bike Counter Analysis, in our most recent blog. Read more here: [url]*"). One of these analytical results describing changes in bicycle use across the United States was shared by the international newspaper The Guardian resulted in more responses online.

4.2 Making sense of civic data: Network structures and discourse opportunities

In this section, we turn our attention to the role of CSOs' in creating and shaping civic data as a communicative object of public discourse. We first present social network analysis results on each case in subsection 4.2.1 and then present the findings of the CDA in subsection 4.2.2.

4.2.1 Networks around central activist accounts

To understand how CSOs have positioned themselves in their respective communities, we calculated Twitter network graphs of the cases based on hashtags. In Figure 2, each CSO in the three cities is shown in the purple nodes while other users in the networks are shown in uniform colors, i.e., green, blue, and orange respectively. The network graph shows how local online discourses of the three cities have evolved and become connected with each other and with different cities.

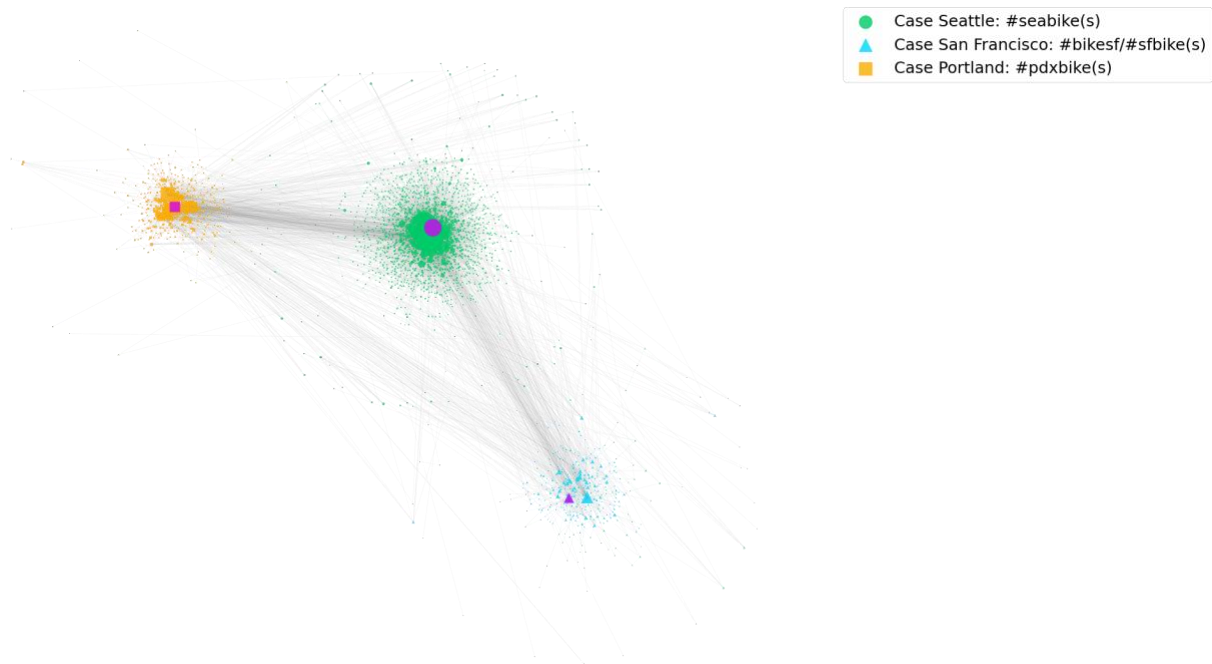


Figure 2. Twitter networks for each CSO in the selected case studies. Each node represents an account while each edge represents a reply or retweet between accounts. The node sizes represent the frequencies of being retweeted and replied to.

Table 1 summarizes basic indicators of each case's network structure. Case Seattle shows very closely aligned edges, i.e. a focused network of accounts, compared to a more thinly and widely distributed network of edges and accounts in Case San Francisco and Case Portland. Regarding degree centrality (i.e., the count of how many social connections each node has), all CSOs are positioned equally central in their hashtag networks. Interestingly, there is a great discrepancy between the cases regarding betweenness centrality (i.e., capturing the amount of influence a node has over the flow of information in a network): For Case B (SF bike coalition in San Francisco) betweenness centrality is comparatively higher, indicating that they serve as an important broker between otherwise rather loosely coupled actors and networks.

Table 1. Indicators of network graph (Figure 2)

	(i) Density of network of hashtags	(ii) Degree centrality of CSO account	(iii) Betweenness centrality of CSO account
Case Seattle	0.012	0.056	0.027
Case San Francisco	0.002	0.051	0.240
Case Portland	0.003	0.040	0.067

Note:

(i) Density of network is calculated separately on each case's sub-graph (#SEAbike(s), #bikSF/sfbike(s), and #pdxbike(s) respectively). $Density = \frac{m}{n(n-1)2}$ where m is total edges and n is total nodes in a sub-graph. A higher score reflects the sub-graph is more dense, meaning more connections between actors exist compared to how many connections between actors are possible.

(ii) Degree centrality is simply a count of how many social connections each node has. Higher values mean that the node is more central in the graph.

(iii) Betweenness centrality captures the amount of influence a node has over the flow of information in a graph. Higher scores indicate a node works as a bridge in the graph.

4.2.2. Experiences of Data: From personal encounters to long-term visions

CSOs' roles in facilitating sharing of personal experiences

After the installation of bicycle counters, the majority of posts in our corpus were about citizens sharing their experience of bicycle counters and being counted by them. These posts generally contain the excitement and positive emotions with self-portrait photos of them with a bicycle counter. Those posts include, for example, “*I’ve been making a point of going over the bike counter whenever I can. Sorta feels like voting...several times a day.*” and “*Was secretly cheering every time we hit a bike counter today on the bicycle track.*” The bicycle counter experience narratives spread into networks and it even nudged others to experience the bicycle counting as well e.g., “[...] *I wanted to be counted!*” CSOs refrained from advocacy and subjective opinions when citizens shared their personal experiences with bicycle counters. Rather, they acted as an information provider by posting new counters’ information and sharing the counters’ cycling data (e.g., posts with the figure showing the increase of bicycle numbers in the city, such as “*Another record! Yesterday, 5,066 bicyclists crossed the Seattle Bike Counter on the Fremont Bridge!*” (Case Seattle). In Case San Francisco the CSO nudged people to experience bicycle counters by posting, for example, “*CONTEST: Guess how many bikes the new Market Street Bike Counter will count on Bike to Work Day. Closest to the actual number wins a free pro tuneup bicycle.*” These types of posts seek to connect individuals’ experiences to collective and visible action on behalf of cycling in the city.

CSOs' roles in generating and disseminating data-driven discourse

Diverse communications containing bicycle counter data become part of CSOs communication, forming an analytical discourse aside from engaging citizens. Analytical discourse contextualizes civic data in a city's sustainability transition. Analytical discourse can be provided by anyone (citizens, data scientists, CSOs, or authorities) both inside and outside of the networks. For example, Case Portland (BikePortland.org) as a civic media organization, has provided numerous bicycle-related articles. These articles include basic patterns of bicycle usages in a month or year and increasing bicycle usages over time. As more data is accumulated, more types of analyzes can be done to make the local context understandable to citizens through data. For example, Cascade Bicycle Club (Case Seattle) initiated a discourse about the economic benefit of bicycle counters in local areas to support business opportunities. Other examples of analytical discourse are shown in Figure 3.

CSOs sometimes comment back to posts within the hashtag networks to address the potentials and meanings of bicycle counters in their cities, e.g., *“Collecting data to improve understanding of biking, will affect future policy”* (Case Seattle). Case San Francisco (SF bicycle coalition) pointed to the challenges of equity regarding who gets counted by sharing their own article about new counting installations in less central districts: *“Real talk: [San Francisco Municipal Transportation Agency]’s doing an increasingly strong job at making sure that *everyone* who bikes gets counted. [url]”* (Case San Francisco).

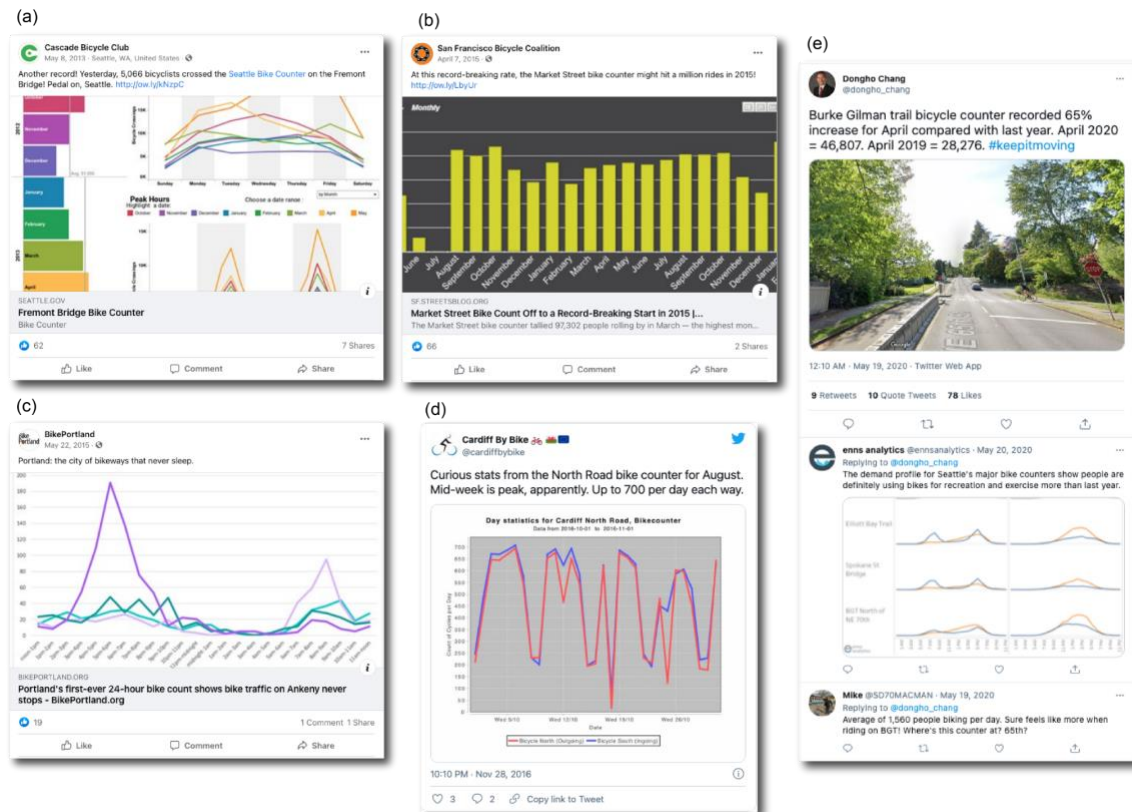


Figure 3. Example posts of analytical discourse related to bicycle counters. The presentation of graphs allows users to understand and interact with bicycle counter data as a communicative object. The posts (a), (b), and (c) are example Facebook posts by the CSOs while (d) and (e) are Tweets from other users in the network.

CSOs' role in connecting citizens to a shared vision of sustainable mobility

CSOs have also used hashtags to mobilize citizens for a joint vision of sustainable mobility. For example, Cascade Bicycle Club (Case Seattle) raised awareness of the city's delay in building its planned bike infrastructure, e.g., "Build a #BasicBikeNetwork now. #SeaBikes." They coordinated on-ground meetings at Seattle City Hall by tweeting: "Join us tomorrow to send a resounding message to City Council: #wecantwait for the #BasicBikeNetwork. [url] #seabikes" (Case Seattle). Through collaborations with other CSOs and citizens, this movement achieved that the plans of the Basic Bike Network were started by 2019 (Seattle Neighborhood Greenways, n.d.).

While hashtags have been mainly used to connect local actors, CSOs have also employed hashtags to connect individual communications that go across geographical boundaries. The hashtag #VisionZero is a

recent example. It is used to call for a framework to eliminate all traffic fatalities and severe injuries while increasing safe, healthy, equitable mobility for all (Vision zero network, n.d.). For example, Cascade Bicycle Club (Case Seattle) called for participation in this movement by posting:

“We need action on #VisionZero now. While people walking or biking are involved in 5% of crashes in Bellevue, we suffer 43% of injuries and fatalities. Join us at 6:30pm Thursday 12/12 at City Hall to tell leaders we can’t wait for safe streets [url]” (Case Seattle)

SF bicycle coalition also tweeted with the hashtag, such as: *“Show City leaders that inaction is unacceptable. #VisionZero meeting today at 2pm. [url]”* (Case San Francisco), echoed by similar calls for action from Portland. These examples illustrate that the CSOs use loosely connected networks to mobilize citizens and policymakers to take actions for sustainable mobility in their cities. The common use of the hashtag #VisionZero also supports our findings from the network analysis (see Figure 2) that CSOs from different cities connect with each other via social media to support common goals.

5. Discussion

CSOs were found to have a strong role in making civic data actionable and relatable for citizens in several ways. In their social media communication, this role can be found in two dimensions that facilitate democratic participatory structures outside the domain of formalized political deliberation through activist interventions and community-focused outreach. In particular, CSOs were found to offer both affective and analytical ways in which overarching socio-political issues can be addressed from a data perspective and a citizen perspective (5.1). They also facilitate a long-term public negotiation over crowd-sourced data as an asset that serves their communities in sustainability transitions and their pledge for safe cycling (5.2).

5.1 CSOs initiate affective and analytical discourses around civic data

The time of installing a bicycle counter typically coincides with a surge in social media activity, allowing numerous citizens to voice their approving or dismissive opinions on these innovations. Papacharissi (2016) described social media as generating a form of “affective publics,” understood as “networked publics that are mobilized and connected, identified, and potentially disconnected through expressions of sentiment” (p. 311). Bicycle-counter discourses around civic data show that affective publics typically produce disruptions/interruptions of dominant political narratives by presenting underrepresented viewpoints and making a rather abstract sensor an object of affective (positive or negative) investment. CSOs here connect dispersed articulations around common concerns while seeking to articulate and promote a shared, collective vision. Once civic data through bicycle counters becomes available, CSOs initiate discourses

based on the data itself and call for participation. Apart from effective identification through personal experiences, CSOs shape analytical discourses with direct implications for policymakers. Civic data then serves as evidence for a changing mobility paradigm allowing different forms of affective connection, new visibility, and ownership. We observed that CSOs provide opportunities for affective identification while also offering analytical discourses based on civic data. Affective identification with the issue (cycling safety) and analytical discourses to endow the issue with public relevance (through civic data) contribute to the central role of CSOs as political actors.

5.2 CSOs enable ownership of civic data as citizens' data

Bicycle counters have matured as a unique form of cities' infrastructure as they gain acceptance among the wider public. Compared to citizen sensors installed in a bottom-up way (Hamm et al., 2021), bicycle counters are mostly installed by cities in a top-down fashion. Yet, bicycle counters in our case studies produce civic data as citizens gain a sense of ownership toward the counters and a feeling of contributing to the generation of data. By sharing their personal experiences of being counted, reporting issues of malfunctions, and expressing pride in their city's move to place counters, users on social media contribute to a sense of community and ownership on various levels of involvement. For example, one of the most liked Tweets (>150) in our corpus was about a bicycle counter being protected during road repair works:

“NOT ONLY did [account of the city's department of transportation] pave a temporary detour so that the 520 multi-use trail could still be used during construction, but they ALSO moved the bike counter so it could still be used too!”

Similarly, some posts show forms of civic pride to see bicycle counters in cities (e.g., *“I think my favourite part of the southernmost section of the 1st street cycle track is the bike counter.”*, *“Never noticed this Cambridge “bike counter” before. So Cambridge.”* or *“More scenes to love in #bikefriendly #SantaMonica: bike counter [...]”*). These articulations on being counted and creating data make cycling more visible to authorities and also car drivers, who command most of the space in public road infrastructure. It facilitates a process of generating evidence that underscores a sustainability transition in mobility that is already well underway. In addition, through dialogue on social media, civic data is interpreted through a range of “epistemic voices” (Elfin 2008 quoted in Foth and Brynskov, 2016) as people are making sense of the data in their everyday lives. In contrast to legacy CSOs, we saw that the selected CSOs have used the dynamics of circulation of communicative objects on social media to develop and sustain a democratic participation structure that “pervades across all touch points of civic life.” (Asad et al., 2017, p. 2296). Coordinating and sustaining long-term discourses around bicycle counters through social media creates opportunities for

citizens to participate at various levels – from posting just one image to organizing a bike rally. CSOs here act as anchors for individuals in fragmented networks to overcome the algorithm-based biases of social media filtering (Chen and Aitamurto, 2019).

6. Conclusion

This study analyzes the role of communication for situating civic data in cities and communities in the context of a democratic participatory structure (SDG 11.3.2). We explored prominent cases of bicycle counters in the United States generating civic data as communicative objects of affective investment by citizens that make data actionable for systemic sustainability transitions. Citizens and CSOs together organize connective action, shaping a public discussion and offering incentives for participation. CSOs sustain long-term networking by fostering a sense of ownership by contextualizing civic data in local civic life as well as trans-local networks and policy. Despite the limitations of considering only social media data from US-based accounts, the study provides important contributions to understanding the challenges and opportunities for CSOs in using social media as a prime site of public negotiation of pressing social issues. Advancing SDG 11.3 in the direction of democratic participatory structures around urban innovation will require developing democratic processes for networked public interventions that bring together dispersed but committed individual actors and networks around a shared vision of sustainability, urban mobility, and safety.

From a democratic point of view, it is problematic that current developments have led to the use of non-accessible mobility data for counting bicycles, e.g. in the form of phone tracking or similar apps. Promoting civic data acquisition and widespread use will require governance structures where data generation and ownership are negotiated in a democratic participatory process in order to make such data actionable and useful for a range of different stakeholders—public and private ones. Relaying such democratic processes to the domain of social media, as this study has shown, can be only a first step towards equitable and inclusive data governance. As sustainability transitions depend on cross-sector collaborations, CSOs become more important for dispersed and networked publics to channel very heterogeneous aspirations of individuals into collective ways in which visions of sustainable society can be achieved.

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